Tangible and Intangible Capital

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Key Points

- Major changes in national accounting were introduced between 1999 and 2012 by recategorizing spending on intellectual property (IP or IPP) as 'final' rather than 'intermediate' output.
- The changes, which sought to give more weight to the impact of technology on the economy, were accepted for their aprioristic plausibility. Their validity can, however, be tested by measuring the returns on equity when IP is treated either as a form of final output or of intermediate output.
- When IP is treated as intermediate the returns on equity are consistent with those derived independently from stock market data, but when IP is categorized as final output they are not. The change has therefore been a mistake and should be rescinded.
- This error is one of many examples of a widespread, unrealistic, indeed romantic attitude to technology, which has been encouraged by the stock market success of high technology companies and the tendency of journalists and investors to confuse the economy with the stock market.
- Growth depends on improvements in technology and the incentives or restraints on corporate management to exploit them. We do not appear to be able to accelerate the rate at which technology improves. But we can change incentives. The romantic attitude to technology is hindering changes to incentives and thus holding back growth.
- One of the adverse consequences of the error made in recategorizing IP has been to divert attention from the need to stimulate tangible investment, which is the only policy likely to significantly accelerate trend growth.
- The key incentives are taxes and subsidies. Corporation tax falls on investment, not on shareholders, and its net revenue should be reduced by cutting the rate or increasing the subsidies on tangible investment.

Introduction

Categorization can have a profound impact on science. A beneficial example is the work of Nicolas Steno who "… changed the world in the simplest and yet most profound way. He classified objects differently."[1] It can also hold back science, as the former Chinese habit of grouping objects into such sets as 'round, brown or squishy' seems to have done.

Knowledge is a social construct; it depends on the models we use and changes as they are accepted, modified and discarded through debate in which scientists are the jury and data the main evidence. Data change when categories are altered and this, like marriage, should not "… be enterprised, nor taken in hand, inadvisably, lightly, or wantonly".[2] Decisions to change data categories should not therefore be made because they appear plausible, and should not be accepted without their validity being tested.

"The capitalisation of IPP[3] has been gradually introduced by the Bureau of Economic Analysis (BEA) through comprehensive revisions of the NIPA[4]. In 1999, the 11th BEA revision recategorized software expenditure by business, NPISH[5] and government. Prior to this revision software expenditure was considered intermediate nondurable consumption in the business sector and final consumption in NPISH and general government. Analogously, after the 14th revision in 2013, the BEA treats the expenditures by businesses, NPISH and the government … no longer as … intermediate goods."[6] No tests appear to have been conducted to justify the major changes that have been made since 1999 in national accounting in the treatment and value of intellectual property products (IP or IPP). This paper sets out to rectify this omission.

[1] *Hen's Teeth and Horse's Toes* by Stephen Jay Gould (1983) W. W. Norton & Co.
[2] The Form of Solemnization of Matrimony (1662) *Book of Common Prayer*.
[3] Intellectual Property Products, termed IPP in the Koh *et al* paper quoted here and more usually, as in this paper, termed IP.
[4] National Income and Product Accounts
[5] Non-profit making organizations serving the private sector.
[6] Labour share decline and Intellectual Property Products Capital by Dongya Koh, Raul Santaeulalia-Llopis & Yu Zheng (2020). *Econometrica* Vol. 88, No. 6.

Data Changes

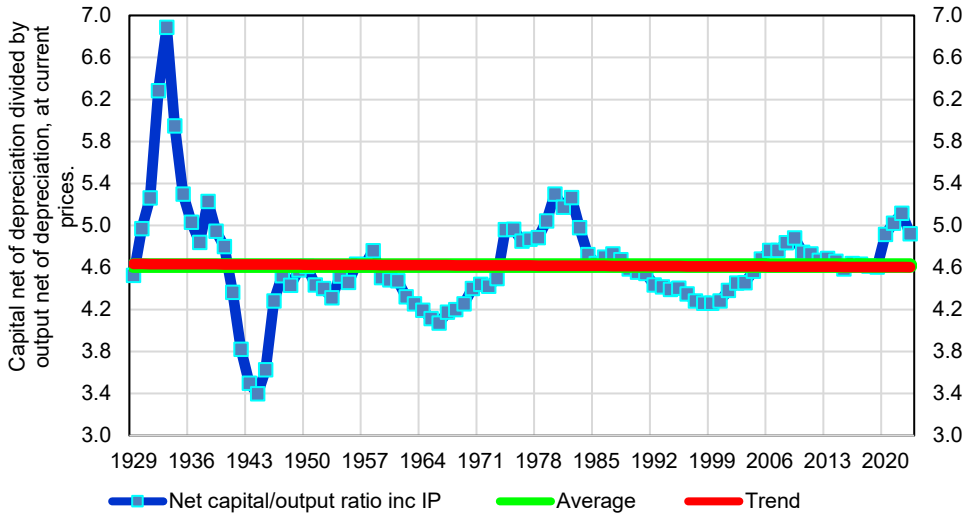
The fundamental change made in national accounting has been to switch IP investment from intermediate to final output. The changes in the US national accounts vary between a small rise in the growth of output (GDP) to huge changes in the levels of business investment and depreciation. Table 1, below, sets out the impact of these changes on US national data for 2023, which are the most recent available.

Table 1: Impact on 2023 US national data resulting from the inclusion of intangible spending in investment

Increase in growth of GDP at constant prices % p.a. over 10 years	0.09
Increase in growth of GDP at constant % p.a. over 20 years	0.07
Increase in growth of NDP at constant prices % p.a. over 10 years	0.08
Increase in growth of NDP at constant % p.a. over 20 years	0.04
% Increase in total capital stock	8.13
% Increase in business capital stock	13.8
% Increase in total investment	46.91
% Increase in total depreciation	48.96
% Increase in business investment	68.85
% Increase in business depreciation	67.61

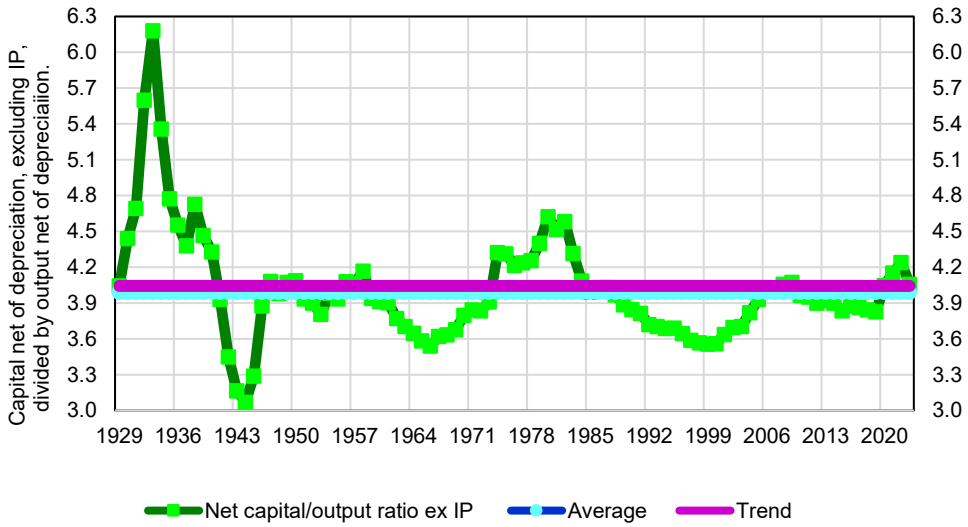
(Data sources: BEA Fixed Asset Tables 1.1 & 1.3 and NIPA Tables 1.1.5, 1.1.6 & 5.25.)

Figure 1. US: Net Capital/Output Ratio including Intangible Capital



Data sources: NIPA Table 1.1.6 & BEA Fixed Asset Tables 1.1 & 1.3.

Figure 2. US: Net Capital/Output Ratio without IP



Data sources: BEA Fixed Asset Tables 1.1 & 1.3 and NIPA Tables 1.1.5 & 1.1.6.

Figures 1 and 2 illustrate why the stationarity of the net capital/output ratio has been generally accepted.[7] Whether or not IP is included as part of the capital stock makes no difference to the probability that the ratio of net value of the produced capital stock/NDP is mean reverting. The conclusion is therefore unaffected by the rate at which IP is depreciated.

Before the changes, economists saw growth as mainly depending on the level of investment. Countries which invested a high proportion of their GDP were those that grew rapidly. The change in national accounting has heavily modified this link. If the official data correctly calculate the rate of depreciation applicable to tangible and IP capital, and the net capital/output ratio is stationary, growth today depends predominantly on the level of tangible investment. This has confused public debate, which has not yet adjusted to this change, particularly in the UK, whose stagnant output has become the key political issue.

Three Stationarities

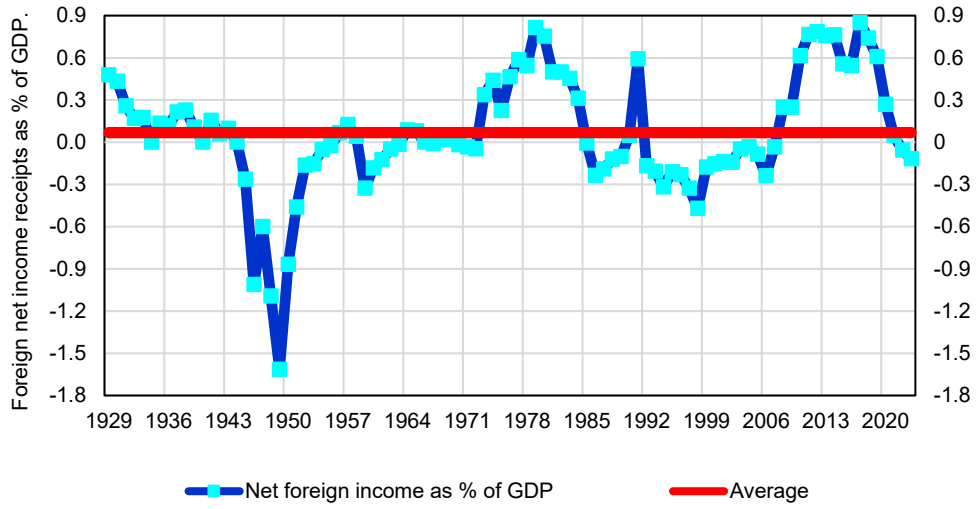
While Figures 1 and 2 are consistent with the net capital/NDP ratio being stationary, the averages around which they vary are significantly different. If IP is correctly depreciated and valued, it takes $4.61 worth of capital to produce $1 of net output (NDP), whereas official national accounts data show that it only takes $3.99 of capital if the change from treating IP investment as a form of intermediate, rather than final, output was a mistake. The validity of the change can therefore be assessed if the correct value of net capital/NDP (K/Y) ratio can be calculated. This can be readily done if the return on capital (Π/K), or the profit share of net output (Π/Y) are also stationary, because (Π/Y)/(Π/K) = (K/Y). If the mean reversion of the net capital/NDP ratio is accepted, it only needs one of these other ratios to be mean reverting for this to be correct for all three.[8]

In a closed economy there are no net payments of interest or rent, as these are simply transfers within the economy. Increases in the level of debt require no savings and can thus make no contribution to changes in the capital stock. All capital is therefore equity. We have two separate ways of calculating the return on equity for the US and, if the US has been nearly a closed economy

[7] The close approximation of the trend to the average provides a strong and readily illustrated way to show the probability that the net capital/net output (NDP) ratio is mean reverting; the figures show that this probability is high whether IP is included or excluded.
[8] The logic is set out algebraically in Appendix 1.

regarding capital transfers, these two sources will give the same answer when the return on equity is correctly calculated.

Figure 3. US: Net Foreign Income



Data sources: NIPA Tables 1.1.5 & 4.1.

We have data for the US on its net transfers of income to and from the rest of the world for the 94 years from 1929 to 2023. As Figure 3 illustrates, such international transfers have always been a very small proportion of the produced capital stock of the US. Over the whole period the US has received net income flows from the rest of the world averaging 0.07% of GDP and 0.02% of its capital stock. Although largely open to flows of trade, and to some extent those of labour, the US has been, in effect, a closed economy in terms of capital flows.

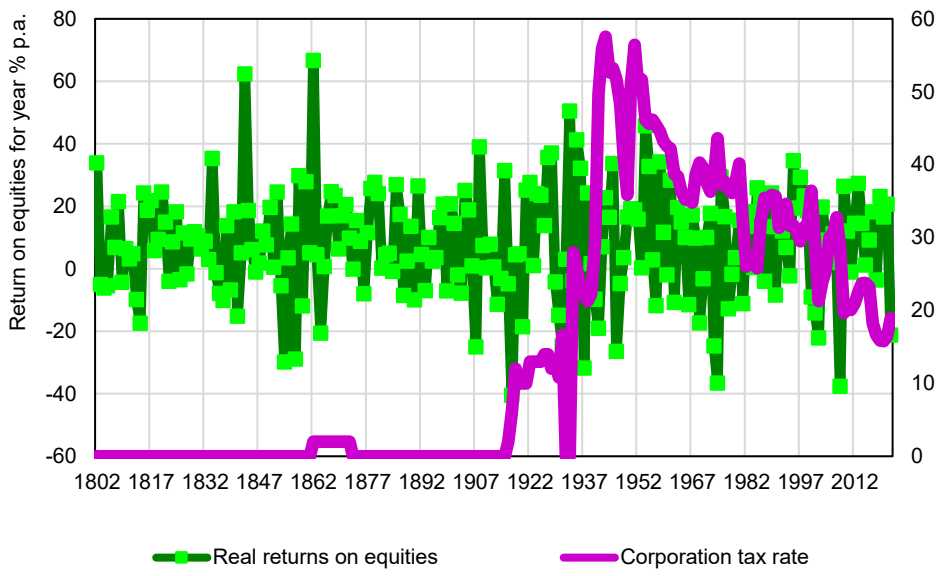
In an open economy, the return on equity for the corporate sector can differ from that for the economy in aggregate, but this cannot apply to the US, as it has so closely resembled a closed one. Had it been open, it could have been a net international owner, lender or debtor, and the country's return on equity would then have been affected by the returns or costs from its foreign assets or debts. However, as the US has been nearly a closed economy, we can use the return on

equity to US shareholders—with great confidence—as needing to match, when assets are correctly valued, the return made on domestic business equity.

We have, therefore, two separate ways of checking the return on US equity: (i) the return on US equity to shareholders and (ii) the return on US net produced capital stock.

US Equity Returns to Shareholders

Figure 4. US: Annual Return on Equity & Corporation Tax Rate



Data sources: For equity returns Jeremy Siegel 1802–1870 & Robert Shiller 1870–2024, for corporation tax The Tax Foundation for 1802–1928, NIPA Table 1.14.

We have data on the annual returns to owners of US equities for 223 years, from 1801 to 2024, and they averaged 6.8% p.a. in real terms, i.e. after allowing for inflation.

Table 2. Real returns to owners of US equities from 1801 to 2024

Period in years	Return % p.a.
1801 to 2024	6.8443
1873 to 2024	6.8013
1929 to 2024	6.5664

Data sources: Jeremy Siegel 1801–1870, Robert Shiller 1870–2024.

These returns appear to have been stationary, and this is illustrated both by the close fit between the average and the trend of the log returns, which is illustrated in Appendix 2, and by the similarity of returns over the whole period 1801 to 2024, and over the shorter periods shown in Table 2. I show these for the periods 1873 to 2024, as covered by the data published by Robert Shiller, and 1929 to 2024, the period for which we have data to calculate the return on US net produced capital stock.

The Return on US Net Produced Capital Stock

The need for a deduction for depreciation depends on whether technological advances are 'putty-putty' or 'hard-baked clay' (aka "disembodied" and "embodied"). 'Hard-baked clay' are those advances which "require tangible investment to make them effective" and 'putty-putty' are those which don't.

"In vintage models of economic growth there have been two predominant assumptions on factor substitution. Solow assumed that capital is pure putty: even after installation a machine can always be reshaped to accommodate any number of workers … . L. Johansen[9] assumed that only before construction can a machine be designed to utilize any number of workers; once it has been built and put in use, it can only be combined with labor in a fixed proportion. Thus capital is putty *ex ante* and clay *ex post*."

Solow, describing the difference between putty-putty (disembodied) and hard-baked clay (embodied), remarked that "embodied improvements in

[9] Substitution versus Fixed Production Coefficients in the Theory of Economic Growth by Leif Johansen (1959) *Econometrica* XXVII.

technique permit an increased output from an "ultimately" smaller input, but require the construction of new capital goods before the knowledge can be made effective. Most casual students of the problem seem to believe that the major part of observed technological progress is of the embodied type, but there is very little solid information on this point."[10]

When seeking to distinguish between putty-putty and hard-baked clay advances in technology, it needs to be understood that the data on the value of the tangible produced capital stock include any value added by the technology embedded in it. Modern equipment has a higher value than that of older vintages because it is more efficient. The value of money spent on research and development (R&D), which has been successful in advancing technology, is thus included in the values ascribed to tangible capital when it takes the hard-baked clay form. This does not necessarily apply to the value of R&D, which has proved successful in advancing technology when it takes the putty-putty form. If IP is categorized as intermediate output, its value is assumed to be embedded in the technology needed to create the equipment; if it is categorized as final output, the assumption made is that IP expenditure has an additional value, i.e. some of it must produce putty-putty advances.

Produced capital is all capital except land. In a closed economy, net additions to the produced capital stock equal net savings, which represent all preserved output, (i.e. all past output that has not been consumed or scrapped), and total produced capital is the sum of past accumulated savings. These include inventories, consumer durables and fixed tangible assets.

Consumer durables are part of the capital stock and are defined in the Fixed Asset Tables by their ownership rather than by their type. "Consumer durable goods are tangible commodities purchased by consumers."[11] When owned by business, which occurs most commonly with automobiles, they are included among fixed assets. Consumer durables should be included in the capital stock of the economy: (i) because any increase in them requires savings which must equal investment, (ii) because they are essential for output, including the need by business for workers at specific locations, and (iii) to avoid anomalous changes in the value of the capital stock when the proportions of consumer

[10] Substitution and Fixed Proportions in *The Theory of Capital* op. cit.
[11] *Fixed Asset and Consumer Durable Goods in the United States 1925 to 1997* by Shelby W. Herman, Arnold J. Katz, Leonard J. Loebach, and Stephanie H. McCulla with assistance from Michael D. Glenn (2003) published by the BEA.

durables owned by households and businesses change, for example as their financing varies between household purchases and leasing. Equally, however, household ownership of consumer durables produces income which is not currently included in gross domestic product (GDP) data.

Appendix 3 describes how the BEA measures depreciation and shows that the method used for tangible assets is unlikely to give rise to errors in measurement. It is, however, probable that the method used will err when applied to intangibles as their measurement is "… extremely difficult because both the price and output of R&D capital are generally unobservable. To resolve these difficulties, economists have adopted various approaches to estimate industry-specific R&D depreciation rates, but the differences in their results cannot easily be reconciled. In addition, many of their calculations rely on unverifiable assumptions."[12] Estimates of value which are unverifiable and unreconcilable must be suspect. IP depreciation can therefore easily be mismeasured.

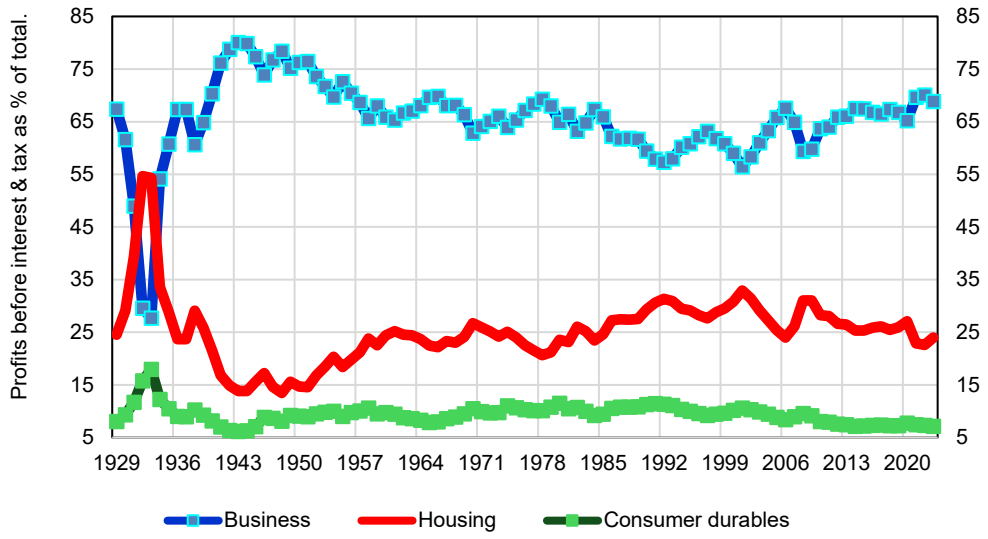
The assumption that the sum of individual companies' IP values will equal that of the corporate sector is also likely to be a fallacy of composition. The positive value of IP to one company will often have a negative impact on the profit, and thus, the value of their competitors' capital. In such instances, any positive goodwill must be matched by an equal amount of ill will.

The US data published since 2012 have been recalculated from 1929 and now assume that IP investment is a form of final output. We can, however, recalculate the data by returning to the previous categorization of IP as intermediate, rather than final expenditure. This not only reverses the major 2012 change but also the relatively minor changes introduced earlier, in which some expenditure, particularly on software, was recategorized as final. The return on capital from the unadjusted official data can then be compared with the return on capital when it excludes IP. Since we also have data on returns to investors, we can see which of the two approaches is most compatible with this completely unrelated source of data, and thereby provide an answer to the question of how fast IP investment should be depreciated, and therefore how we should value intangible capital, without having to rely on unverifiable assumptions.

[12] *Depreciation of Business R&D Capital* by Wendy C. Y. Li, US Bureau of Economic Analysis, October 2012.

Measuring Profits and Capital

Figure 5. US: Shares of Total Profits. (including IP depreciation)



Data sources: NIPA Tables 1.3.5 & 1.14 and BEA Fixed Asset Tables 1.1& 1.3.

The economy has three sources of profits: business, home ownership and consumer durables. Their contributions to total profits, including IP depreciation, is illustrated in Figure 5.

Table 3. US Sectors' percentage contribution to total profits

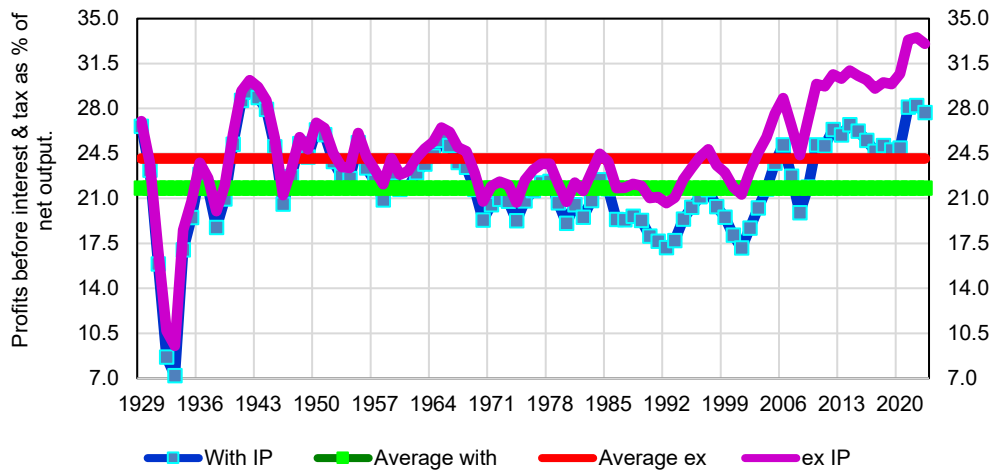
	Business	Housing	Consumer durables
1929 to 2023 average with IP	64.86	24.37	9.25
1929 to 2023 without IP	67.81	22.45	8.53
2023 with IP	68.88	23.99	7.13
2023 without IP	67.81	22.45	8.53

Data sources: NIPA Tables 1.3.5 & 1.14 and BEA Fixed Asset Tables 1.1 & 1.3.

As Table 3 shows, the contributions of the three sectors to total profits vary little over time, regardless of whether IP is included or excluded.

The first step needed to calculate the total profits of the economy is to measure these sectors' respective contributions to net output, and the second is to attribute the correct proportion of these outputs to profits. The BEA publishes data on the gross output of business and housing (NIPA Table 1.3.5), and on the rates of depreciation applicable to their produced assets, both in total and for IP. I calculate the net output of consumer durables from their current value. As this is all profit and has no labour share, its net output is the equity return on that value. Its long-term return has been 6.8% and, since 1929, 6.6%. For the purposes of calculation I take 6.7% as my best estimate of the average, including that used to value the output of consumer durables, but the results and any conclusions that follow, are not sensitive to the precise return assumed.

Figure 6. US: Corporate Profit Margins with and without IP

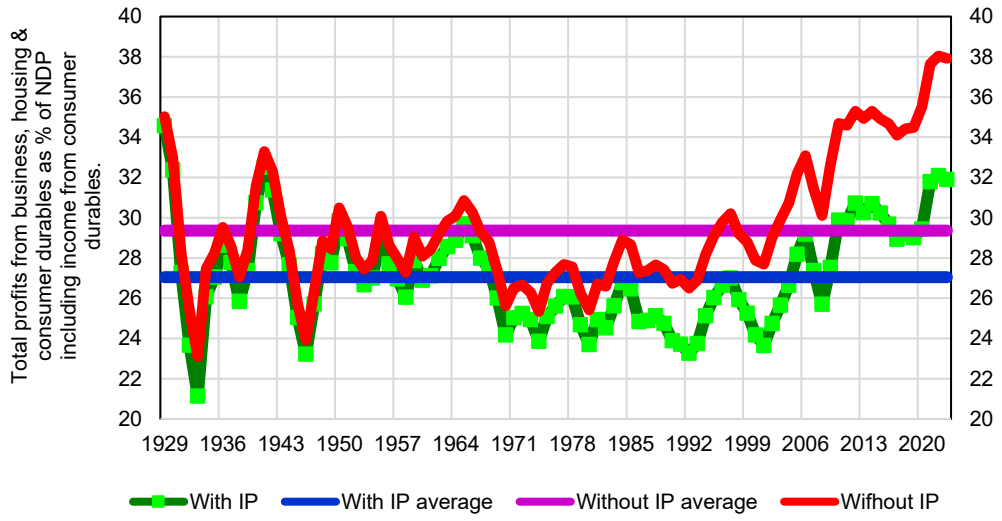


Data sources: NIPA Table 1.14 and BEA Fixed Asset Tables 1.3 & 1.5.

We have profit margins for incorporated business, as illustrated in Figure 6. On the assumption that the same margins will apply to the business sector,

including unincorporated enterprises, the profit share of NDP is illustrated in Figure 7. Without the added depreciation when IP is included, profit margins are higher, particularly in recent years, than they are when calculated using unadjusted data, as shown in NIPA Table 1.14.

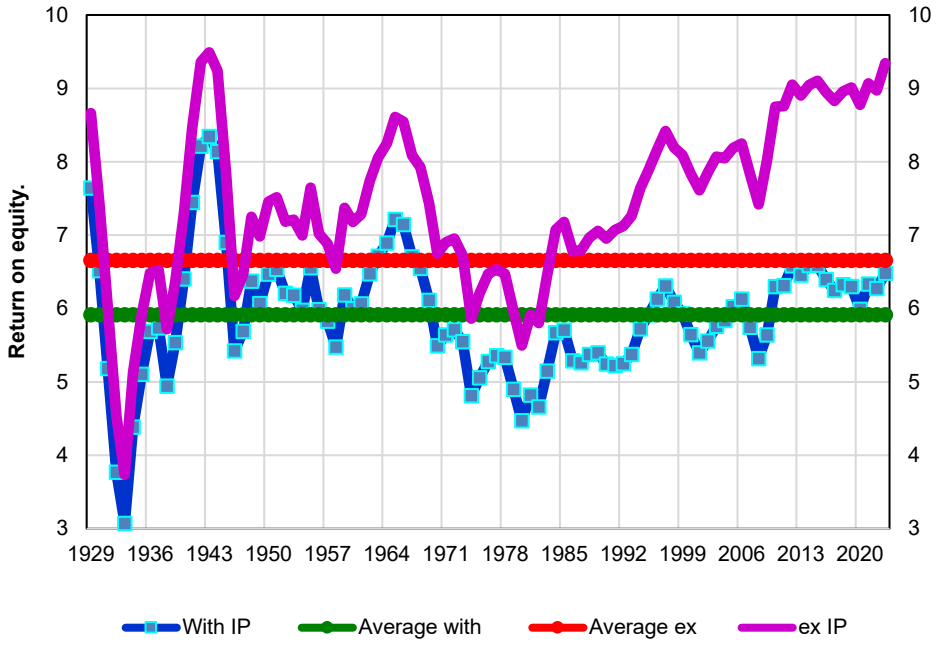
Figure 7. US: Profits as % of NDP (including income from consumer durables)



Data sources: NIPA Tables 1.3.5 & 1.14 and BEA Fixed Asset Tables 1.3 & 1.5.

To calculate the correct rate of IP depreciation, the next step, after establishing the annual level of profits, is to relate these profits to the annual values of the capital stock—both with and without IP—available from BEA Fixed Asset Table 1.1.

Figure 8. US: Return on Equity including and excluding IP



Data sources: NIPA Tables 1.3.5 & 1.14 and BEA Fixed Asset Tables 1.1, 1.3 & 1.5.

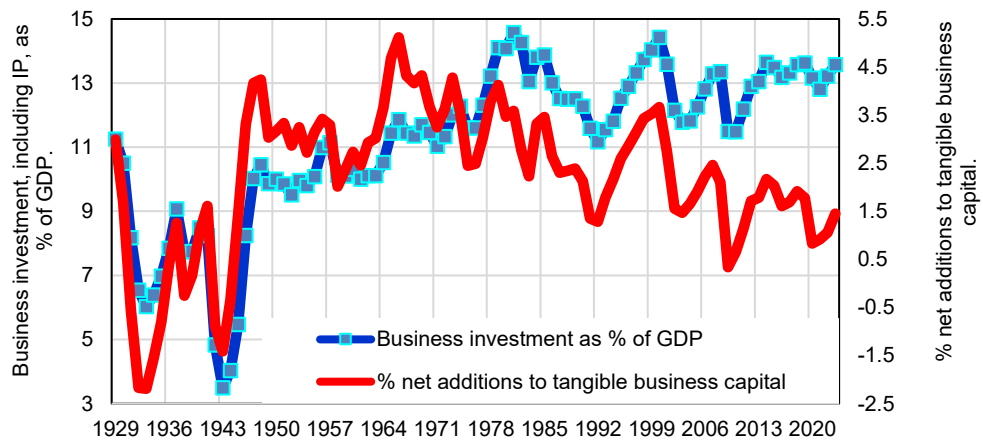
The average (geometric mean) return on equity from 1929 to 2023 is 5.91% when IP is included and 6.66% when it is excluded (Figure 8). The second of these is in line with the long-term average return on equity. The result without IP must therefore be preferred to that with IP, and it follows that the data do not support the changes made, particularly the 14th change made in 2013.

Confusion has Followed the Change

The 11th and 14th changes in US national accounting,[13] which recategorized IP investment as final rather than intermediate output, are shown to have been a mistake. Diverting attention from the need to boost the level of tangible investment has been one of its adverse consequences. It is generally accepted that the produced net capital/NDP ratio is stationary, as shown in Figures 8 and 9. It follows that it is the level of tangible investment which effectively determines the growth rate of output, whether the official estimates of tangible and IP investment are used or if IP depreciation is accelerated towards 100%—i.e. if IP were again treated in national accounts as intermediate rather than final output.

When economists or journalists confuse the level of total investment with the growth of the net capital stock, their expectations for the economy's trend growth rate are dramatically inflated. As there is no labour share of housing output, its capital output ratio is about four times higher than that of business and the growth of business tangible capital is thus the main determinant of output growth.

Figure 9. US: Business Investment & Net Additions to Tangible Business Capital

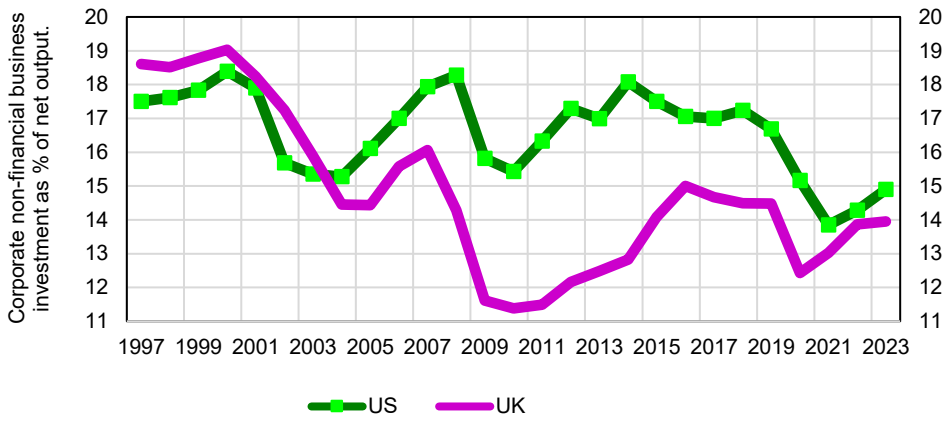


Data sources: NIPA Table 1.1.5 and BEA Fixed Asset Tables 1.1, 1.3 & 1.5.

[13] The changes were internationally agreed and included in the System of National Accounts (SNA), similar changes have been made in the ONS data for the UK.

When IP investment is treated as intermediate output, net additions to business tangible capital stock provide a proxy for the trend growth rate of output. As Figure 9 illustrates, the growth rate indicated by additions to tangible capital is currently 1.5% p.a. The trend growth rate is also affected by climate change[14] and, as this negative impact is strengthening, the current trend growth rate of the US is probably less than 1.5% p.a. There is also no scope for any additional cyclical boost, as the current capital/NDP ratio of the US is close to its average level of 3.99 (Figure 2).

Figure 10. UK & US: Corporate Non-financial Tangible Investment



Data sources: ONS (L5YR, L5YW, L5ZA, L5ZG, FARR, FACQ, JGJW & NSRK), BEA Fixed Asset Table

I have not been able to find the necessary data to replicate Figure 9 for the UK, but I have been able to compare the levels of non-financial corporate investment relative to net output, and I show these in Figure 10. If, as seems likely, the capital/NDP ratios are similar, then the UK trend growth rate will be around one percentage point per annum slower than that of the US and is thus likely to be no greater than 0.5% p.a.

The confusion that has resulted in these changes in national accounts was illustrated in a recent press comment, which claimed that "Britain's economic

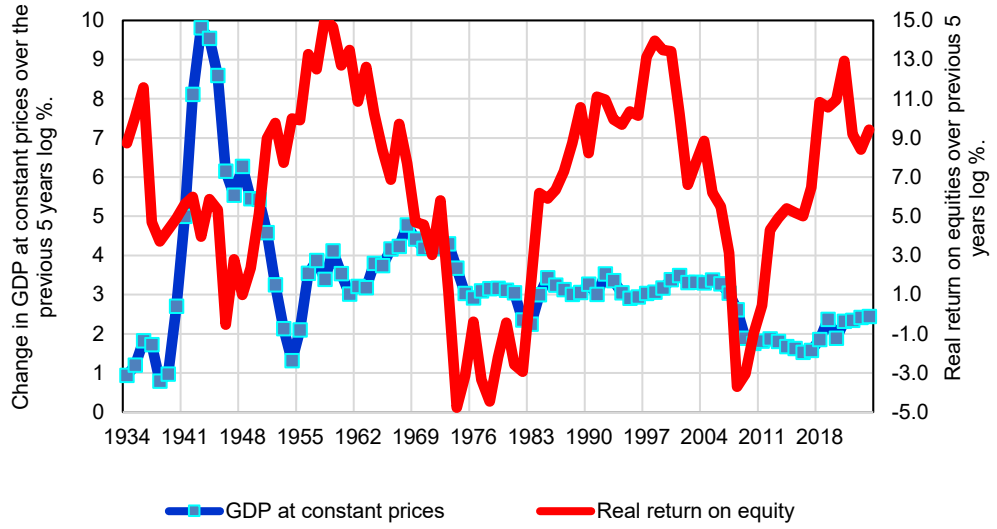
[14] My paper on this is currently near finalisation.

gloom is overdone" and was based on a graph showing "business investment is on the up". This showed a rising trend since 1997 and thus contrasts with the heavily falling trend shown in Figure 10.[15]

Companies and the Economy

The myth that investors in the stock market benefit from economic growth, combined with the importance of the stock market for those with at least some financial assets, has resulted in the two being regularly confused, not only by journalists and investment bankers, but among politicians and economists, and it is sadly one that the contrary evidence seems largely incapable of denting

Figure 11. US: Economy and Stock Market



Data sources: NIPA Table 1.1.6 & Robert Shiller 1870–2024

Figure 11 illustrates, when measured over five years, the lack of any relationship between real stock market returns and the growth of the economy measured by GDP at constant prices. This should not surprise, as returns are

[15] *Financial Times* editorial board 3rd January 2025.

stable over time, as Figure 4 illustrates, while growth varies and has been well below its post-1929 average this century, at a time when stock market returns have been particularly high. The economy does respond to the stock market in the short-term but only indirectly, via interest rates, to changes in trend growth and the consequent need for more savings. The most marked short-term response is the onset of recessions to sharp falls in share prices.

Over time companies have increasingly outsourced parts of their activities. Manufacturers used to internally undertake a range of jobs which today they often buy from suppliers—for example pay-rolls, canteens, pensions and transport. Some of the most successful companies today, such as Amazon, Apple, Google and Microsoft have taken this to the point at which the tangible capital which they own is small compared with their turnover and, importantly for the stock market, with their profits.[16]

It is widely assumed that the economy reflects this change and that (i) the output of manufacturing has fallen as a percentage of GDP and (ii) that services require less capital than manufacturing. The first of these assumptions may well be correct, though the degree is probably much less than generally assumed. This is because data on the output of manufacturers have tended to include the output of all those working on a 'manufacturing site' and, when jobs are outsourced, their output is shifted in the data from manufacturing to services without its nature changing. But even, as seems plausible though probably overstated, the assumption (ii) that services require less capital than manufacturing is shown by the data to be a mistake.

As Figures 1 and 2 show, the ratio of the value of the net capital stock to net output (NDP) is mean reverting, and it would not have been had the contribution of services to NDP been on a significant upward trend. Had the decision to categorise IP as final rather than intermediate output been correct, and services' output grown as a proportion of GDP, there would have been a relationship between the changes in the importance of services and the capital required for a given level of GDP. But, if IP has been correctly categorised as final output, the currently published data would be correct, and these show that output (GDP) has grown more rapidly than income (NDP) as depreciation has risen relative to both GDP and NDP. Although published data show a stable ratio

[16] *The Corporation in the Twenty-First Century* by John Kay (2024) Profile Books Ltd.

of capital to NDP, they also show a rising ratio of capital to GDP. If it is assumed that services have become a rising proportion of output, official GDP data indicate that services are more, rather than less, capital intensive than manufacturing.

It seems likely that services and manufacturing require the same amount of capital when measured by value, and that the rise, according to official data in the ratio of capital/GDP and in the likely increase in the ratio of service/manufacturing output, is not the result of services being more capital intensive than manufacturing, but reflects the mistake of treating IP as final, rather than intermediate, output.

The probability that services and manufacturing are equally capital intensive applies, however, only when capital is measured by value rather than volume. If, as also seems likely, the efficiency of tangible capital, which is all hard-baked, changes at different speeds for services and manufacturing, then, measured by volume, their relative needs for capital will vary. This may be an important consideration for the economy, particularly in terms of international trade. A reduction in international trade, arising from tariff barriers aimed at 'reshoring' manufacturing, may therefore have a less negative impact on growth in countries raising tariffs than the consequent decline in world output efficiency would suggest if applied equally to all countries.

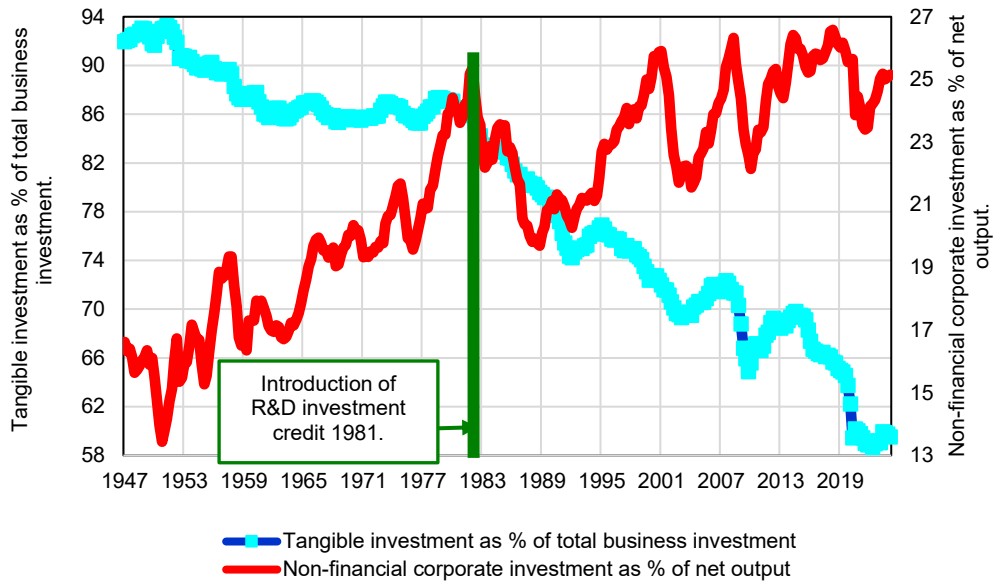
The high returns on equity, recently achieved by companies which have combined outsourcing with advanced new technology, have raised questions over whether returns on equity have ceased to be mean reverting. This must be a possibility, and it is more credible in the US today than usual, as the return on equity is at an all-time (i.e. post-1929) high (Figure 6). As the capital/NDP ratio appears to be mean reverting and currently very near its average level (Figure 2), the high return on equity must be driven by unusually high profit margins and, as Figure 7 shows, it is. While there is no set time limit for a ratio to remain high without debarring it from being considered mean reverting, the longer it takes for a usually high or low ratio to move towards its average, the less convincing its status as mean reverting must be. I expect US profit margins to fall, but I accept that the longer this is delayed the less convincing will be the Stock Market Model and any other economic models, which assume the mean reversion of profit margins.

Two Ways to Boost Growth

Figures 4 and A1 show that the real return on US equity appears to be mean-reverting around 6.7%. In the short-term investment responds, in Keynes's words, to "the animal spirits of entrepreneurs", but such swings of confidence have evened out over time and investment takes place when the expected return on equity is at least 6.7%. The number of projects for which the return is expected to meet this hurdle rate varies with their expected cash flow and the payment of corporation tax. As the profit share, which is measured before interest and tax, is mean-reverting, the long-term profit flow depends on the efficiency of the technology embedded in the new capital and thus its expected net capital/NDP ratio. The two variables that determine the level of investment are thus the expected capital/NDP ratio and the level of corporation tax. Policies designed to increase investment thus need either to increase the efficiency of new capital or to reduce the cost of corporation tax, which can be achieved in several ways, as I set out in Appendix 4, among which cutting the tax rate or increasing the level of subsidies are the most effective.

Growth does not necessarily require new investment. Putty-putty technology increases the efficiency of the capital stock without any additions to its quantity, but, as the correct level at which IP should be depreciated is virtually 100%, advances in technology have taken the form of hard-baked clay and we have no reason to expect this to change.

Figure 12. US: Business IP Investment



Data sources: Z1 Table F. 103 and NIPA Tables 1.1.5 & 1.14

Growth thus requires either a cut in corporation tax or an improvement in the rate at which hard-baked clay technology improves, either of which will increase the level of investment. In the UK and the US, both tangible and IP investment are subsidised, but whereas IP investment is also allowed as an expense for corporation tax, this is limited, in the case of tangible investment, to the level allowed for depreciation. IP investment has been favoured, and consequently grown, relative to tangible investment, as Figure 12 illustrates for the US.

The greater subsidising of IP compared to tangible investment has been accompanied by a slowdown in productivity. It probably started before 1975 and has continued throughout the twenty-first century. Claims of a pickup from around 1995 have been regularly rebutted, for example, in 2000[17] and again in

[17] Does the "New Economy" Measure up to the Great Inventions of the Past? by Robert J. Gordon (2000) *Journal of Economic Perspectives* Vol. 14, No. 4.

2022[18]. It thus appears to have been a policy mistake, which seems to have been encouraged by (i) a romantic attitude to technology, (ii) a wish to believe, contrary to the evidence, that corporation tax is a tax on shareholders' wealth rather than investment, and (iii) the mistaken assumptions used in TFP (total factor productivity) growth accounting.

Figure 4 compares the return on equity with the level of corporation tax and are totally unconnected. Corporation tax is paid by companies and thus reduces their cash flow, it must therefore reduce one or other of its constituents, which are profits after tax and depreciation. As the return on equity is unaffected by the level of corporation tax (Figure 4), it must either (i) fall on depreciation with profits unchanged, or (ii) it must reduce profits and the value in the capital stock by an equal proportion. But the second of these proves, on investigation, to be impossible. New investment occurs when the expected return on equity matches the hurdle rate, either because a fall in bond yields reduces the amount of equity needed to finance investment, or because the value of new capital, once installed, is greater than that of the existing stock, due to an advance in technology; this will not occur if a rise in corporation tax causes the value of new investment (its replacement cost) to fall below its current production cost.[19] The equilibrium result of corporation tax must therefore be a reduction in depreciation without any change in profits. This will happen if corporation tax lowers investment (as this lowers growth) and depreciation varies with the rate of change in labour productivity.[20]

TFP seeks to assess the efficiency of new investment, but I have shown that it fails to do so because it uses the value of the capital stock, which depends on its efficiency, thus rendering any assessment of efficiency impossible because of its circularity.[21] "Andrew Smithers rejects the conventional accounting framework as a means of determining the contribution of investment to economic growth on the grounds that the technology of the time is embedded in investment as it takes place. This technical progress and investment are intertwined in a way which growth accounting does not generally recognize. In

[18] Why is productivity slowing down? by Ian Goldin, Pantelis Koutroumpis, Francois Lafond, and Julian Winkler (2024) *Journal of Economic Literature* Vol. 62, No. 1.
[19] A General Equilibrium Approach to Monetary Theory by James Tobin (1969) *Journal of Money, Credit and Banking* Vol. 1, No. 1.
[20] Neoclassical Growth with Fixed Factor Proportions by R. M. Solow, J. Tobin, C. C. Weizsacker & M. Yaari (1966) *The Review of Economic Studies* Vol 33, No 2.
[21] *Productivity and the Bonus Culture* by Andrew Smithers (2019) Oxford University Press.

this case very stringent assumptions are needed for the growth accounting framework to function—most notably the labour/capital ratio has to be as flexible on old capital as it is before the capital is installed. Such a putty-putty proposition seems unlikely to be true."[22] Martin Weale's assumption is shown to be correct by the return on equity without IP (Figure 9), being the same as that to US shareholders (Figures 4 and A1), while that including IP (Figure 8) is significantly too low.

The long-term average return on equity of around 6.7% is the "hurdle rate" and companies invest when the expected return on the equity needed to finance new investment at least matches that level. The amount of new investment that qualifies rises when new technology lowers the capital/net output ratio for new plant or if the return on existing technology is raised by a reduction in corporation tax. The improvement in technology that has resulted in the subsidising of IP appears to have been weak, and when corporation tax has been cut, the response has been strong. The growth in Ireland, with a low tax rate, and the fluctuations in the UK growth relative to France and Germany (Appendix 5), are examples of the strong response of growth to cuts in corporation tax, when it applies to tangible investment.

[22] Foreword by Martin Weale to *Productivity and the Bonus Culture* op. cit.

Conclusions

Major changes in national accounting introduced since 1999 in the categorisation of IP have been a mistake and should be rescinded.

- **Effectiveness of IP Subsidies**
  The subsidising of IP has a poor return in terms of its impact on accelerating growth. In contrast, subsidies for tangible investment and reductions in corporation tax rates are highly effective.
- **Tangible Investment and Economic Growth**
  Subsidising tangible investment is clearly a sensible policy for boosting growth.
- **Issues with TFP as a Growth Measure**
  TFP is a mistaken approach to growth accounting.
- **Corporation Tax and Investment**
  Corporation tax is essentially a tax on investment and does not reduce the return on equity to shareholders.

If, as this paper assumes, likely in common with most economists, that profit margins are mean-reverting, their decline seems overdue. If this does not occur, a significant change in macroeconomic theory, including the Stock Market Model, will be needed.

Appendix 1
The Relationship between Capital, Output and Profit

By Jude Smithers.

The ratios of produced capital/output (K/Y), profit/output (Π/K) and the profit share (Π/Y), are all mean reverting and, as the stationarity of two requires that of the third, the evidence for any two gives support for the validity of the third.

We start with the equation for the Return on Equity:

$\text{RoE} = (\frac{Y}{K}) \times (\frac{\Pi}{Y})$ ……1.

We differentiate both sides

$d/(\text{RoE})/dt = d/(Y/K)/dt \times (\Pi/Y)$…… 2.

We then apply the product rule

if it were, the correct algebra would read (by the 'product rule'):

$$\frac{dRoE}{dt} = \left[\frac{d(\frac{Y}{K})}{dt} \times (\frac{\Pi}{Y})\right] + \left[(\frac{Y}{K}) \times \frac{d(\frac{\Pi}{Y})}{dt}\right] \text{……3.}$$

As $t \to \infty$ we know

$d(Y/K)/dt = 0$ and $d(\Pi/Y)/dt = 0$

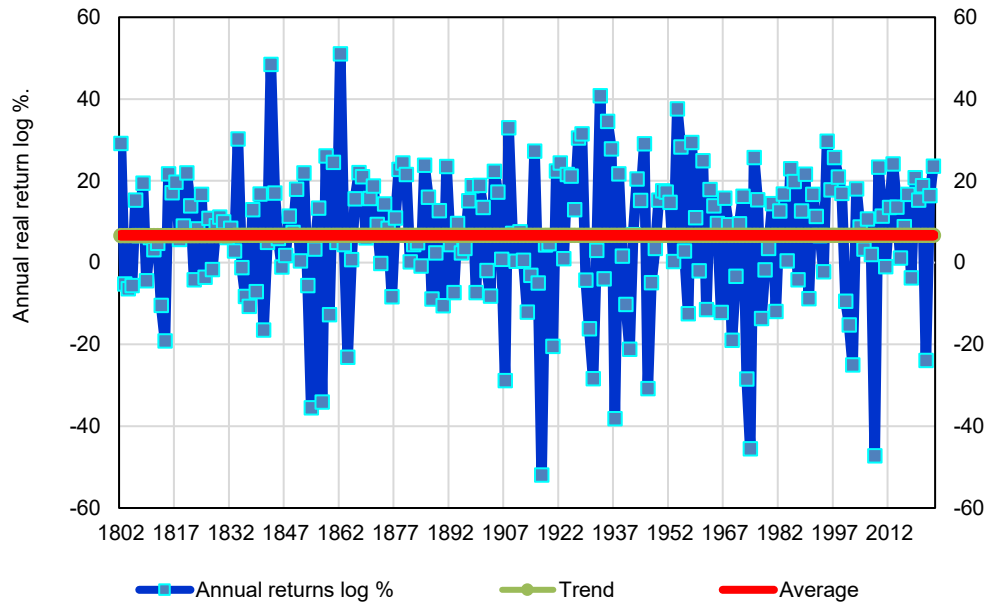
Therefore, by substituting these terms into equation 2:

$\lim t \to \infty \; d(\text{RoE})/dt = 0$

This is a specific case of the general rule that if there are three independent variables A, B & C, and A/B and A/C are both mean reverting, we know that B/C is also mean reverting.

Appendix 2

Figure A1. US: Real Annual Equity Returns



Data sources: Jeremy Siegel 1801–1870 & Robert Shiller 1870–2024.

Figure A1 shows the annual real returns on US equities as log percentages, so that the same positive and negative returns have the same difference from the average, and the closeness of the trend to the average provides a visual way to illustrate their probable mean reversion.

Appendix 3
The Calculation of Depreciation

The US Bureau of Analysis (BEA), when estimating national data, use the terms 'depreciation' and 'capital consumption' for the same entry.[23] It defines consumption of fixed capital (CFC) as "the decline in the value of the stock of assets due to wear and tear, obsolescence, accidental damage, and aging. In principle, the current-cost value of the capital stock is its market, or replacement, value; that is, the value for which the assets in the stock could be bought or sold in that year."[24] The difference over a year between the value of assets, which are obtained by surveys of their current prices, is the charge made for depreciation. As prices in the second-hand market fluctuate along with unemployment, with short-term blips in demand, the rate at which they fall is smoothed to avoid distortions, which are mostly due to recessions. This approach is applied to all items for which there are adequate second-hand markets, including land, buildings and equipment. It is difficult to see how it can be reasonably argued that the resulting data are not accurate.

The value of structures is calculated from the cost of construction after depreciation, which is measured by the mean service lives of fixed produced assets, with value declining geometrically (based on the Hulten-Wykoff estimates). "The mean service lives are estimated from a wide variety of sources"[25] and I have not encountered claims that they have been incorrectly estimated, nor that the depreciation method used is wrong. The claims made about the value of real estate apply only to the value of land and not to that of structures and their cost of construction.

As the net produced capital/net output ratio is stationary, changes in the value of land reflect growth rather than contribute to it. Claims about land values do not, therefore, justify assumptions that the rate of depreciation is mismeasured.

Fixed produced capital is apportioned in the BEA's Fixed Asset Tables between equipment, structures and intellectual property (IP or intangibles). I have not encountered objections to the valuations ascribed to either equipment or structures and, as explained above, it seems unlikely that the BEA's approach

[23] For example, the entries in BEA Fixed Asset Table 3 for depreciation are identical with those in NIPA 1.1.5 and others labelled capital consumption.
[24] *Fixed Assets and Consumer Durables* op. cit.
[25] *The measurement of depreciation in the US National Income and Product Accounts* by Barbara M. Fraumeni (July 1997) BEA Survey of Current Business.

can be faulted. There are, however, great problems with the valuation of intangibles because the results of most investment in intellectual property (IP) are not priced in second-hand markets. Measuring depreciation for IP is certainly difficult and is perhaps impossible as the BEA appears to suggest. "The premise of my model is that business R&D capital depreciates because its contribution to a firm's profit declines over time … Although important, measuring R&D depreciation rates is extremely difficult because both the price and output of R&D capital are generally unobservable. To resolve these difficulties, economists have adopted various approaches to estimate industry-specific R&D depreciation rates, but the differences in their results cannot easily be reconciled. In addition, many of their calculations rely on unverifiable assumptions."[26] Estimates of value which are 'unverifiable' and 'unreconcilable' must be suspect and IP depreciation can therefore easily have been mismeasured.

The use of surveys establishes the value of second-hand equipment under competitive conditions, but the BEA does not use this approach for valuing IP, "because both the price and output of R&D capital are generally unobservable". It is however possible in some instances because there are markets, albeit limited ones, for patents and for companies whose main asset lies in their intellectual property. There is, however, a compelling argument that, if this approach were applied, it would overstate the value of IP for business in total; due to its failure to allow for the negative impact on the profits and assets of other companies—it would be a fallacy of composition.

There is therefore a major difference between the value and rates of depreciation for tangible and intangible assets, with those that are applied to tangible investment and capital being unlikely to be wrong, but those that apply to IP being highly suspect.

[26] *Depreciation of Business R&D Capital* by Wendy C.Y. Li, US Bureau of Economic Analysis, October 2012.

Appendix 4

Factors Affecting the Effective Level of Corporation Tax

The effective level of corporation tax can be varied in several different ways:

(i) By changing the headline rate.
(ii) By reducing the amount actually paid by giving credits for investment, either tangible or intangible.
(iii) By not charging corporation tax on dividend payments, as occurred under the UK's advanced corporation tax (ACT).
(iv) By changing depreciation allowances.
(v) By not changing these allowances to allow for changes in inflation.

The effective level of corporation tax is therefore often very different from the headline rate and the revenue which is attributed to it even in some official data may be woefully misleading.

Subsidies for investment, changing allowances, rises in inflation, and reductions in the headline rate all reduce the real cost of corporation tax. The long-term impact depends on the effective level of corporation tax as a percentage of profits that emerges as a result. The speed at which the economy responds is also important, and I favour subsidies for all forms of tangible investment as being the most effective way of accelerating rises in investment in response to reductions in the effective rate of corporation tax.[27]

[27] This is set out more fully in Chapter 21 of *Productivity and the Bonus Culture* op. cit.

Appendix 5
Confusion over ACT

The fall in the UK's corporation tax headline rate from 33% in 1998 to 19% in 2017 was accompanied by a decline in business investment. This has often been cited to support erroneous claims that cutting corporation tax does not stimulate investment. In fact, the effective rate of corporation tax in 1998 was only about 16%, and the near doubling of the rate was a major cause for the dramatic fall in UK business investment which then followed and is illustrated in Figure 10. The misunderstanding arises from the existence in 1998 of a withholding tax on dividend income which was called advanced corporation tax (ACT). This was a misnomer as it was a way of collecting income tax, which did not affect the recipient's liability, and was therefore usually reclaimed or offset by the share owner. It was deducted from the dividend when paid and therefore did not reduce corporate cash flow, which it would have done had it been a form of corporation tax. The effective level of corporation tax is often very different from the headline rate and the revenue, which is attributed to it even in some official data, may be woefully misleading.

ACT was introduced in 1973 and abolished in April 1999; while it operated, tax was deducted from dividends at the corporation tax rate. As it was a withholding tax on income and, as such, was reclaimed or offset against the recipients' liability to income tax, it produced almost no net government revenue. Net ACT revenue should therefore have been recorded as an income tax receipt, but in the tax and national data it seems to have been recorded as part of the revenue from corporation tax. As it lowered income tax receipts by nearly the same amount, this was highly misleading and greatly overstated the revenue from corporation tax before ACT's abolition.

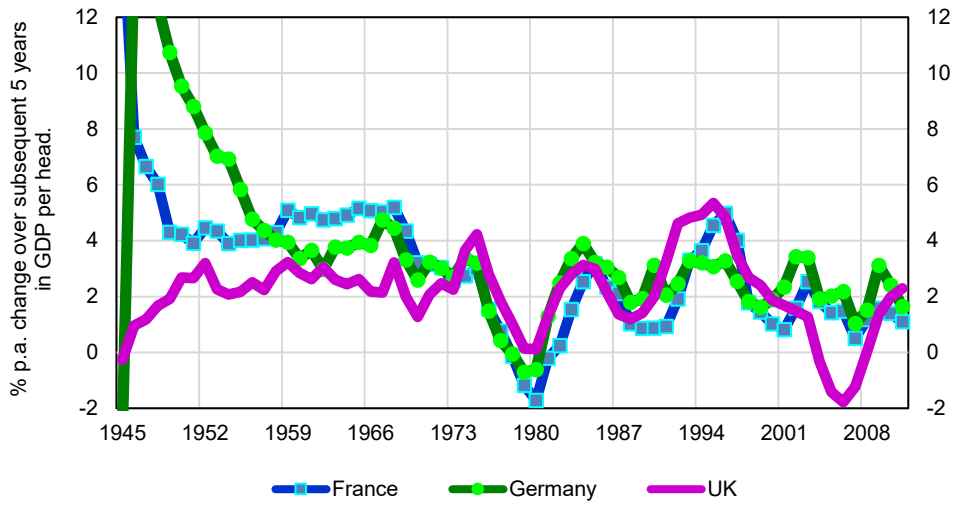
Table A1. Illustrating the Apparent and Effective Rates of UK Corporation Tax before and after the Abolition of Advanced Corporation Tax (ACT)

	Before April 1999	After April 1999
	Headline rate 33% & payout ratio 50%	
Profits before tax	100	100
Retained profits	50	50
Mainstream tax on retained profits	16	16
Mainstream tax on distributed profits	0	16
Gross dividend	50	50
ACT deducted at source	16	0
Income tax offset or reclaimed	16	0
Net tax revenue	16	32
Published revenue	32	32
Headline tax rate	33%	33%
Effective tax rate	16%	32%

The rates of income and corporation tax varied during this period, as did the dividend payout ratio, but the broad impact can be seen in Table A1, which shows that when ACT was abolished the effective rate of corporation tax was doubled. The impact was so misunderstood at the time that it was generally vilified, not because of its effect on investment and growth, but as a "raid on pension funds", which it wasn't, as their short-term returns continued to vary with share prices and their long-term returns were unaffected.[28]

[28] Those who misunderstood the impact included the actuaries, who advised Chancellor Gordon Brown that pension funds would suffer a £67 billion loss of the actuarial value of their assets as a net result of a combination of policies including the ACT change.

Figure A2. France, Germany & UK: Changes in Living Standards 1945 to 2016



Data source: GDP per head Angus Maddison project database 2018.

The abolition of ACT had the effect of doubling the tax on business investment and seems likely to have made a significant contribution to the dramatic fall in UK investment which occurred immediately after 1999, as illustrated in Figure 10, and thus to the sharp fall in the UK's growth this century. It does not demonstrate that the rise in corporation tax was the sole, or even the most important, cause of the sharp fall in business investment, which varies over the short-term particularly from fluctuations in "the animal spirits of entrepreneurs". Claims that corporation tax has no impact on investment are often made because it is assumed that the rate fell from 33% in 1998 to 17% in 2020, when in fact it rose. In practice, as explained above, the effective rate increased sharply during the first decade of the twenty-first century. A significant part of the post-2000 fall in UK investment and growth must be attributed to the ill-considered decision to abolish ACT without halving the basic rate.

Figure 10 shows that business tangible fixed investment, and thus trend growth, has declined since 2000 in both the UK and the US. It is probable that

the disincentive to invest, introduced by the bonus culture,[29] was a major cause of this weakness in both countries, with the impact in the US being partly offset by lower corporation tax and amplified in the UK by its increase. [30]

Table A2. % p.a. changes in standards of living, measured by GDP per head

	France	UK	Germany
1945 to 1973	6.45	2.1	3.87
1973 to 1998	1.56	2.49	2.14
1998 to 2016	1.65	1.31	2.15

Data source: Angus Maddison Project 2018. (GDP per head at constant purchasing power)[29]

Prior to Brexit, the UK's growth, compared with that of France and Germany, had gone through three major phases, which I set out in Table A2.

The one clear change in the UK, which coincides with its relatively strong performance from 1973 to 2000, was the change in corporation tax. This was effectively halved in 1973 by Chancellor Anthony Barber and then doubled in 1998 by Chancellor Gordon Brown. These changes resulted from the introduction of ACT in 1973 and its abolition in 1998. Assuming a 50% payout ratio, the introduction of ACT thus resulted in halving the effective tax rate and that of its abolition of doubling it.

In addition to the effective level of corporation tax, the most important determinants of growth in any single country are the speed of change in technology, the country's ability to exploit its advances and thus on the level of education and the impact of changes in the environment. All these are likely to have been remarkably similar in France, Germany, and the UK, once the devastation of World War II had been repaired. The fact that living standards

[29] *Productivity and the Bonus Culture* op. cit.

[30] The Angus Maddison project notes that to compare the relative growth of living standards the best comparison is that made using GDP per head measured at constant purchasing power. The faster growth of UK living standards shown by GDP per head from 1973 to 1998 is, however, also shown when GDP is measured at current exchange rates. As the population of the UK has persistently grown more rapidly than those of France and Germany, the same pattern is shown in terms of total GDP by either measure. The data are set out in Appendix 5.

grew significantly more rapidly in the UK between 1973 and 2000, when the effective rate of corporation tax was halved by the existence of ACT, is convincing evidence of its impact on growth.

Acknowledgement: I am grateful for the help of Kevin Coldiron in finalising this paper and to Jude Smithers for writing Appendix 2.